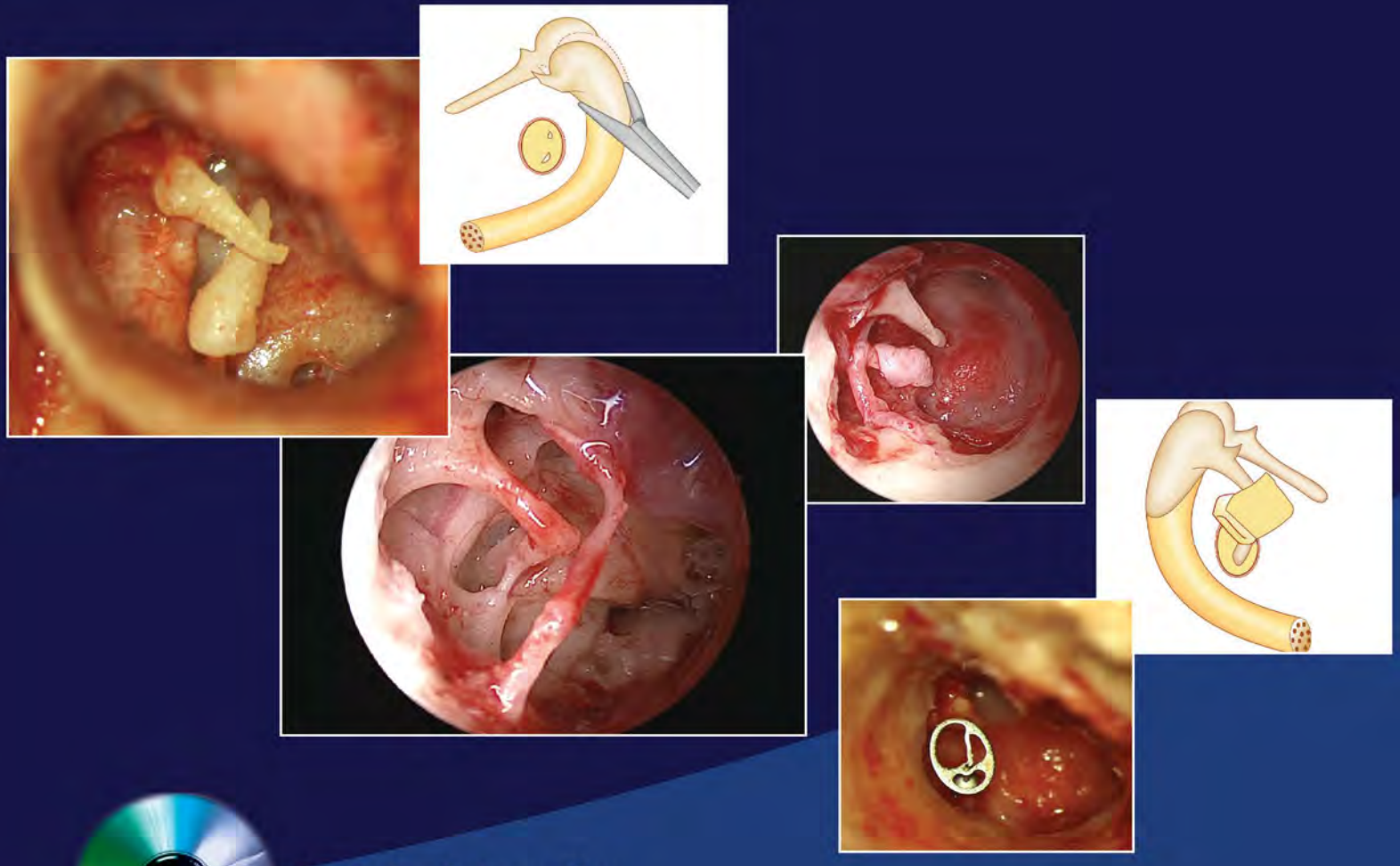
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Atlas of Ossiculoplasty





Includes Interactive CD-ROM

Author
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Forewords
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KP Morwani

JAYPEE

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CHAPTER 3

Etiology and Factors Affecting the Result of Ossiculoplasty

ETIOLOGY

The causes of ossicular chain necrosis or fixation can be categorized into fixation and discontinuity.

Fixation

- Malleus head ankylosis, either congenital or secondary to tympanosclerosis
- Tympanosclerosis involving malleus and incus, with or without stapes/footplate
- Fixation of stapes footplate in cases of otosclerosis
- Adhesion bands in the middle ear.

Discontinuity

- Erosion of ossicles to different extents, either by granulation or cholesteatoma disease
- Trauma: The most common ossicular injury in temporal bone trauma in descending order of frequency is as follows:
  - Incudostapedial joint separation
  - Incudomalleal dislocation
  - Fracture of the stapes superstructure
  - Fracture of the malleus
- Congenital or neoplastic causes.

FACTORS AFFECTING THE SUCCESS/RESULT OF OSSICULOPLASTY

Many surgeons and masters in the past have tried to form certain indices to depict the probabilities of success in ossiculoplasty.

The first relevant scoring system was formed in 1994 by Kartush—middle ear risk index (MERI).

Middle Ear Risk Index (Table 1)

Middle ear risk index was formed to predict the success rate of middle ear reconstruction procedures. For predicting the accuracy of the surgical results of middle ear ossiculoplasty, the status of middle ear and its ossicles has to be ascertained. Middle ear risk index includes different classifications, which are as follows:

1. Austin-Kartush classification of ossicular defects
2. Fixation of ossicles
3. Ear drum perforation
4. Presence or absence of cholesteatoma
5. Belluci's classification of otorrhoea
6. Presence or absence of effusion/granulations in middle ear
7. History of previous surgery

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TABLE 1: Middle ear risk index table

Risk factor	Risk value
1. Ossicular defect	
O: M+I+S+	0
A: M+S+	1
B: M–S+	3
C: M–S–	4
2. Fixation of ossicles	
E: Ossicular head fixation	2
F: Stapes fixation	3
3. Tympanic membrane perforation	
Absent	0
Present	1
4. Presence or absence of cholesteatoma	
5. Otorrhoea	
Dry	0
Occasionally wet	1
Persistently wet	2
Cleft palate	3
6. Granulations/effusion in middle ear	
No	0
Yes	1
7. Previous surgery	
None	0
Staged	1
Revision	2

Table 1 showing MERI including risk factors and values given to each factor. After middle ear risk index, many more new indices have been devised to further analyze the factors affecting the results of ossiculoplasty, though no one index is considered the standard.

Important Factors Affecting the Outcome of Ossiculoplasty

According to the author, the important factors affecting the outcome of ossiculoplasty can be summarized into:

1. Eustachian tube functioning
2. Aeration of middle ear via ventilation pathways
3. Dimensions of ossiculoplasty graft
4. Status of the mucosa of middle ear
5. Status of residual ossicles
6. Posterosuperior canal wall reconstruction
7. Canal wall up/canal wall down mastoidectomy
8. Culture sensitivity testing of the ear discharge before surgery.

Eustachian Tube Functioning

Retraction of drum which usually leads to chronic ear disease, is most commonly seen secondary to Eustachian tube dysfunction, predominantly known to occur in the pediatric age group. In this age group, the commonest cause for Eustachian tube dysfunction is usually recurrent upper respiratory tract infection, in the form of recurrent adenotonsillitis, rhinitis, or rhinosinusitis followed by various pathologies of nose, and paranasal sinuses (Figures 1 and 2).

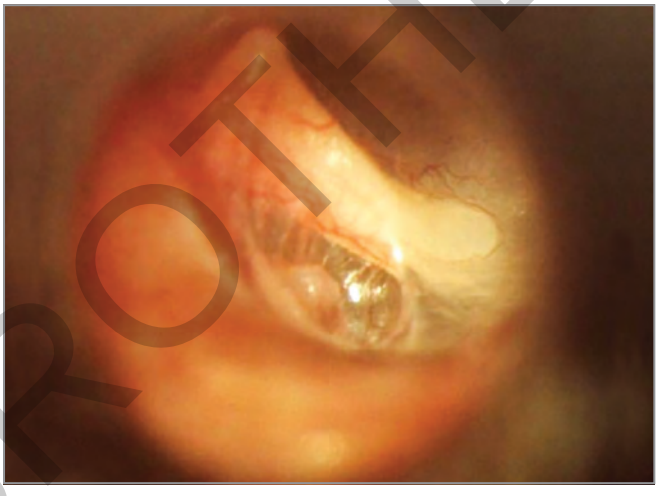


FIGURE 1: Right ear showing retraction of tympanic membrane in posterior quadrant. This patient had history of recurrent infection nose and throat since childhood.

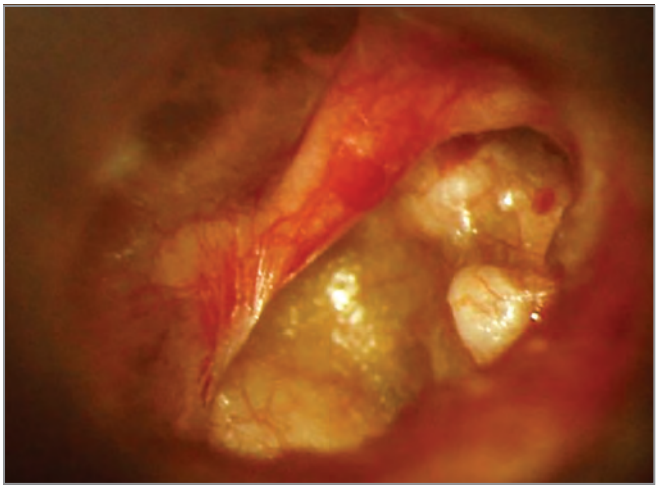


FIGURE 2: Left ear of the same patient showing severe retraction in posterior quadrant, leading to necrosis of long process of incus and incudostapedial joint.

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Steps Taken Before Surgery

Before deciding for surgery in patients with otitis media, we must make sure that every condition which can cause malfunctioning of Eustachian tube has been diagnosed and treated, respectively. Conditions like deviated nasal septum, adenotonsillitis, allergic rhinitis, and nasal polypi must be treated completely before performing ear surgery.

Steps to be Taken During Surgery

Eustachian tube patency should be checked in each case after removal of disease and hypertrophic mucosa in the middle ear. Push 1 mL saline into the Eustachian tube opening to wash out any foreign particle, mucosal plug, and remove any polypoidal tissue and cholesteatoma matrix filling the opening of eustachian tube in the middle ear (Figure 3). Unless this is done, there are chances of leaving behind disease tissue leading to recurrence of disease in the future.

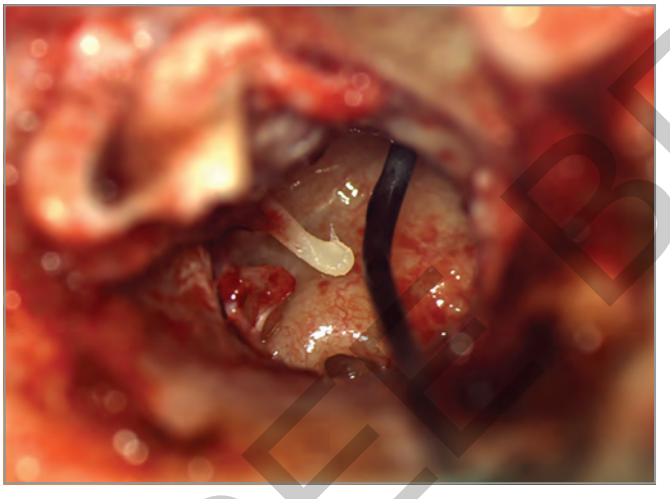


FIGURE 3: Physiological saline being pushed into Eustachian tube.

Aeration of the Middle Ear via Ventilation Pathways

As explained in chapter 2 (*Anatomy of Middle Ear*), all the epitympanic spaces receive their aeration via the large anterior tympanic isthmus only (as in 75% cases tensor fold is complete). In rest of 25% cases where the tensor fold is incomplete, an alternative pathway between supratubal recess and anterior epitympanum is available (Figure 4).

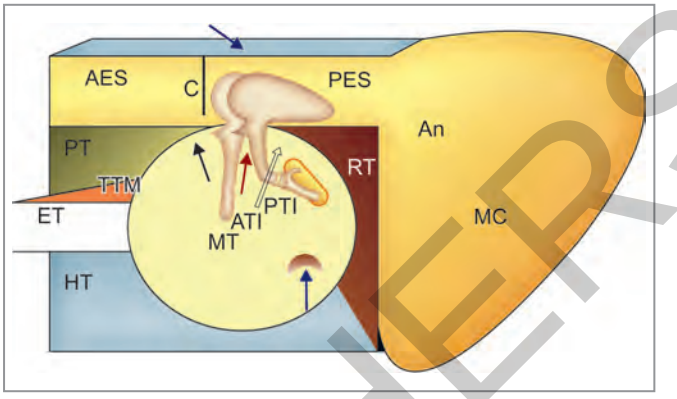


FIGURE 4: Diagrammatic depiction of middle ear with its ventilation pathways. **AES,** Anterior epitympanic space; **PES,** Posterior epitympanic space, **C,** Cog; **An,** Antrum, **MC,** Mastoid cavity; **MT,** Mesotympanum, **PT,** Protympanum, **HT,** Hypotympanum, **RT,** Retrotympanum; **TTM,** Tensor tympani muscle, **ET,** Eustachian tube; **Red arrow,** Anteriortympanic isthmus; **Hollow arrow,** Posterior tympanic isthmus; **Black arrow,** Tensor fold; **Blue arrow,** Tegmen tympani.

While performing ossiculoplasty in chronic otitis media cases, we must check these ventilation pathways, specifically the "isthmus" (Figures 5 and 6). A blocked isthmus is mostly due to mucosal fold variations, inflammatory webs and exudates, retracted membrane, diseased attic mucosa, and cholesteatoma. If the isthmus is found blocked, it should be cleared and patency should be achieved between lower and upper compartments as well as antrum and mastoid cavity. Also, if the tensor fold is found completely blocking the ventilation between

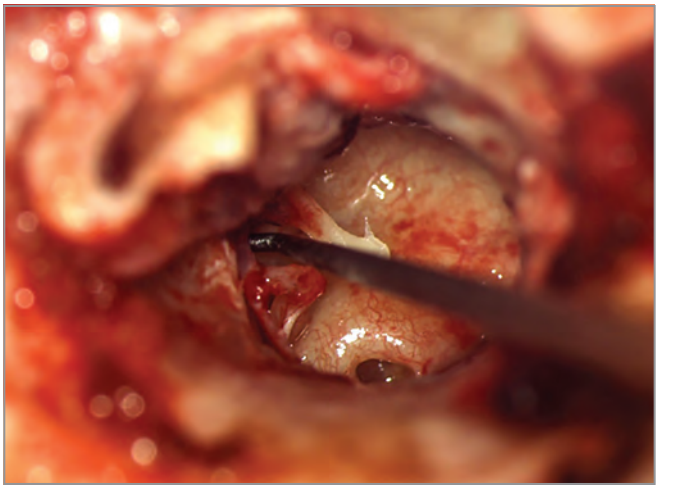


FIGURE 5: Anterior tympanic isthmus, main ventilation pathway.

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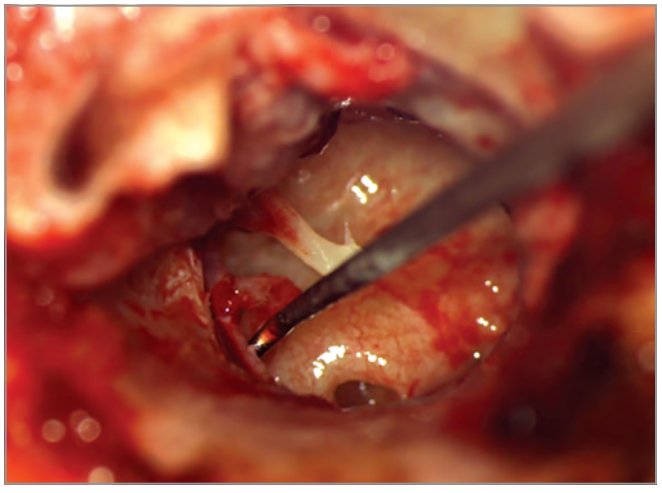


FIGURE 6: Posterior tympanic isthmus.

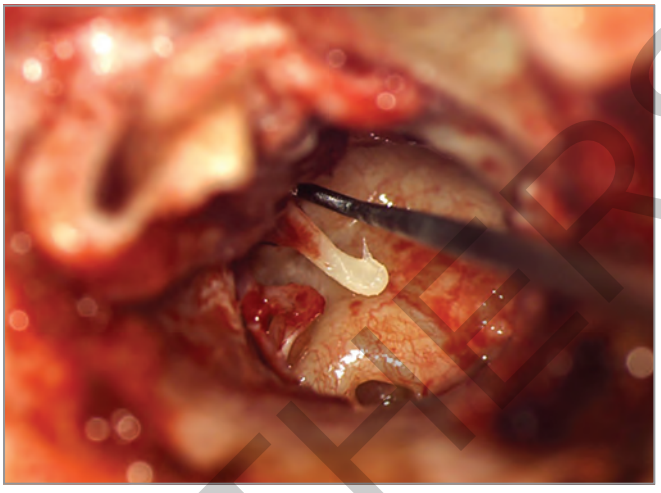


FIGURE 7: Instrument is pointing towards accessary pathway through tensor fold.

anterior epitympanic space and supratubal recess, it can be excised to create an additional ventilation pathway.

Unification of the upper and the lower units through the creation of a large tympanic isthmus and an accessory route through the tensor fold will form good ventilation pathways within the middle ear, which forms the basis of a good outcome of ossiculoplasty. Surgery must ensure ventilation to all parts of the epitympanum.

Blockage in the isthmus can also lead to inadequate ventilation of the anterior and posterior attic, as well as the antrum and mastoid cavity. Any blockage should be addressed and cleared to achieve complete patency.

Dimensions of Ossiculoplasty Grafts

The depth/height of middle ear space is approximately 4 mm which is to be maintained after reconstruction of ossicular chain. So when we are using any ossicular graft, the height of graft, whether it is an interposition or columella graft, becomes very important (Figure 8). If it is a canal wall up situation, the graft must reach up to the level of posterior bony annulus and if its canal wall down situation, the height of graft or assembly should be at least 1.5 mm lateral to lateral margin of horizontal fallopian canal.

Interposition Graft



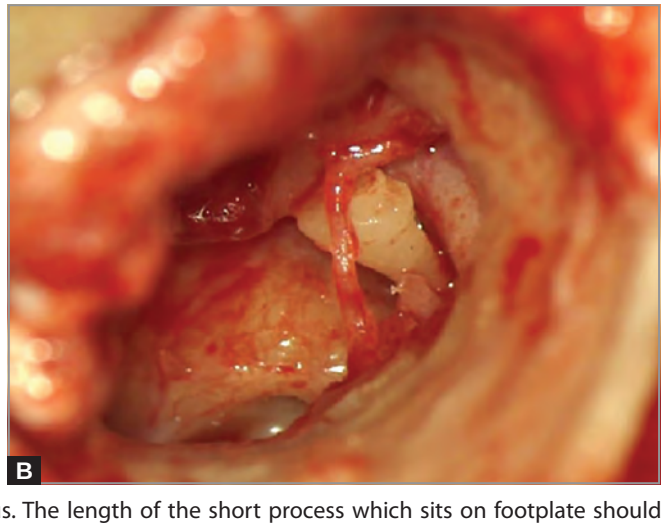


FIGURE 8: Incus reshaped and placed between footplate and incus. The length of the short process which sits on footplate should equal the height of middle ear.

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Columella Graft

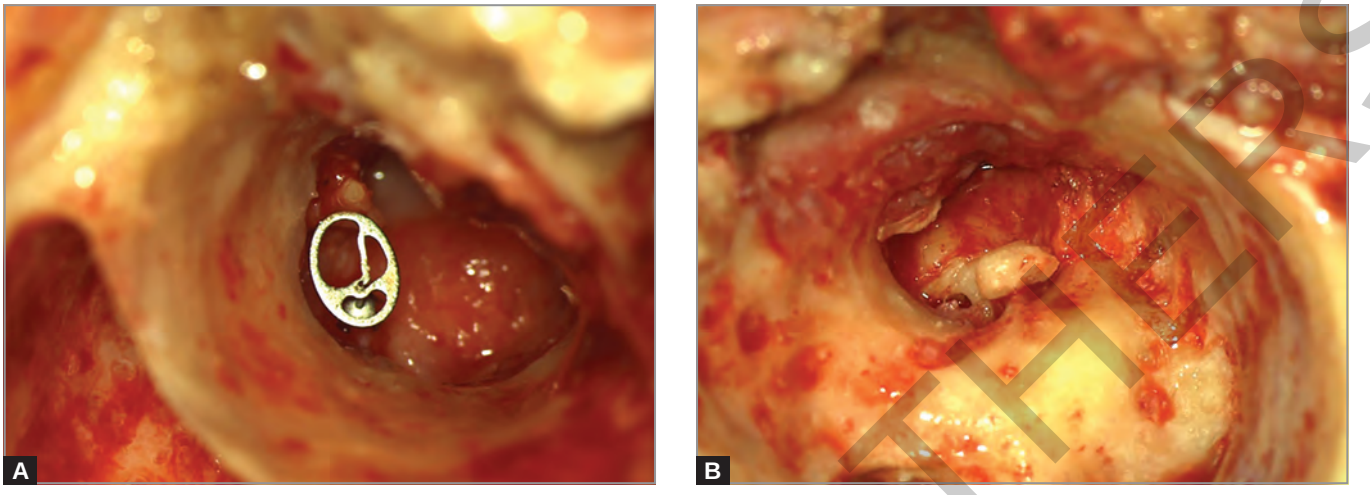


FIGURE 9: **A,** Titanium partial ossicular replacement prosthesis on stapes head. Accurate height of shaft of partial ossicular replacement prosthesis is decided before placing it on stapes head. **B,** Head of malleus over stapes.

Status of Mucosa over Medial Wall of Middle Ear

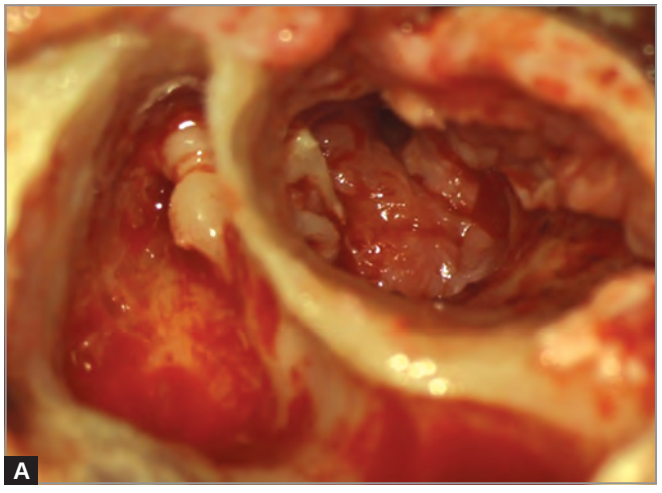
In middle ear, mucosa exchanges gas in the same way as the alveoli in the lungs. This gas exchange occurs between the capillaries and the middle ear mucosa. Inflammation of the mucosa leads to derangement of the mucosal hemodynamics.

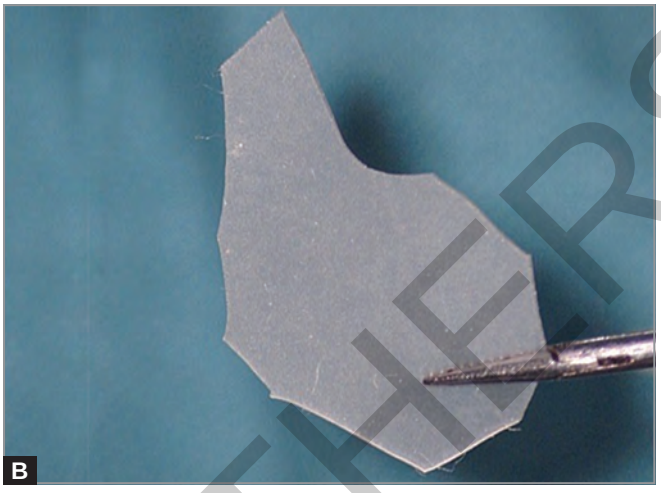
During ossiculoplasty, while removing the disease from the middle ear or the adhesion bands between tympanic membrane and the medial wall of middle ear, the mucosa can get disrupted leading to exposed bone in the promontory area (Figure 10). This can lead to formation of adhesions between the mucosa and the ossicles or the neotympanic membrane leading to failed ventilation and finally failure of the ossiculoplasty.

If the mucosa gets disrupted then either a sialastic sheet or gelfilm can be placed on the medial wall of middle ear to cover the exposed bone, promote the healing of mucosa and prevent adhesion formation in future.

According to literature, the size of the sialastic sheet is important in the outcome of ossiculoplasty and healing. The sheet is cut in a certain specific shape and size. The thickness of sialastic sheet is 0.5 mm (Figure 10B). Some surgeons place it from the Eustachian tube to the meso- or the hypotympanum. According to Professor Sana, the sheet needs to be bigger and should be extending to the epitympanum and the aditus ad antrum, as well for better aeration (Figure 10C).

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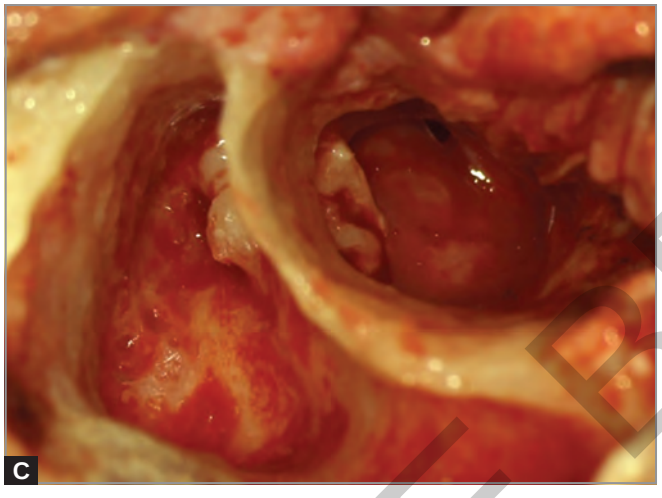


FIGURE 10: **A,** Middle ear mucosa damaged; **B,** sialastic sheet (thickness 0.5 mm); **C,** it is placed on the medial wall of tympanic cavity, covering whole of the mesotympanum, hypotympanum, and a tail extending into the Eustachian tube opening in middle ear.

Status of Residual Ossicles

The residual structures include:

- Tendon of tensor tympani and handle of malleus
- Usable incus
- Stapes S/S.

If we divide the various situations in ossicular pathologies into three categories, we have:

- First category is when all three structures are present. This situation gives us results closest to normal, i.e., air bone gap closure up to 15 dB, as we can use the incus as an interposition graft between the stapes head and the handle of malleus
- Second category is when the suprastructure of stapes is absent. There is not much change in the results. The incus can still be used as interposition graft between the handle of malleus and the footplate of the stapes
- Third category is when either the handle of malleus, incus, or both are absent. A columella graft can be placed on either the stapes head or the footplate. This assembly has results inferior to the above two categories.

An intact malleus handle conserves the natural lever arm ratio and thus produces an effective catenary lever at the drum, which positively affects the result. The malleus plays an important role in concentrating sound energy and stabilizing the new tympanic membrane. It also stabilizes the interposition graft (incus/allografts).

Posterosuperior Canal Wall Reconstruction

After procedures like epitympanotomy (removal of the lateral wall of the attic), epitympanectomy (along with the lateral wall, the head of malleus and the body of the incus are also removed), and atticoantrostomy (removal of the lateral wall of the attic and antrum), posterosuperior bony canal wall reconstruction is mandatory. This is done to avoid formation of any retraction pocket in the region of attic in the future which may lead to recurrence of disease.

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The reconstruction can be done with either a thick cartilage graft harvested from the tragal, conchal or floor cartilage, or a bone graft harvested from the squamous temporal bone.

Canal Wall Up/Canal Wall Down Mastoidectomy

Does it matter?

Not really. The result of ossiculoplasty is not affected by a canal wall up or down technique, if the middle ear space is maintained. This is achieved by placing a stable ossicular graft of an optimal height in the middle ear and performing posterosuperior canal wall reconstruction/obliteration of the mastoid cavity as per the requirement of the case.

Thus, the hearing results in the canal wall down mastoidectomy group are comparable to the hearing results in canal wall up mastoidectomy cases. This means that the surgeon can choose canal wall down mastoidectomy approach for treating a wide or recurred lesion and expect to achieve a similar hearing results as with a canal wall up mastoidectomy approach.

Role of Culture Sensitivity

As in all chronic diseases, the cases with chronic otitis media and more specifically the cases with cholesteatoma harbor many resistant bacteria and fungi. An ear swab should be collected from the affected ear and sent for culture and sensitivity to identify the offending organism and the correct antibiotic treatment is to be given before performing the surgery. We usually try to make ear dry by giving the specific antibiotics a couple of weeks before surgery. Though the deep seated infections can only be cleared after removal of disease tissue but superadded infections can be controlled before surgery and this definitely helps in improvement in results of tympanoplasty. As the field has been made infection free before the surgery, the removal of disease and reconstruction of ossicles can be taken up in single stage only.

DEFINING SUCCESS

Attempts have been made to standardize the success of ossiculoplasty. Pre- and postoperative air and bone conduction thresholds are measured at four designated frequencies (0.5, 1, 2, and 3 kHz), then averaged.

Success is defined in terms of:

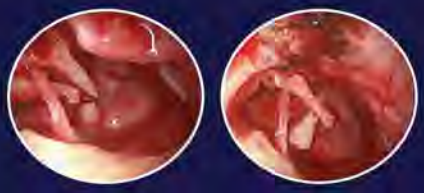
- Bringing mean postoperative air bone gap to less than 20 dB
- Bringing the operative ear to within 15 dB of the contralateral ear
- In patients with severe mixed hearing loss, ossicular reconstruction useful in enhancing the use of amplification.

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This book is an illustrative monogram dealing with different techniques of ossicular reconstruction, addressing a variety of ossicular pathology. Intra operative photographs are accompanied by diagrams to clearly illustrate details of the technique used.

Key Features

- Review of different materials and techniques of ossicular reconstruction.
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- Highly illustrated.
- More than 1200 images and 30 videos to complement the text.



Madhuri Mehta MS (ENT) did her graduation and post-graduation from Government Medical College, Rohtak. At present she is at NC Jindal Institute of Medical Sciences and Research, working in the capacity of Director of ENT Department and Medical Superintendent of the Institute, Hisar. She has been practising otolaryngology with special interest in Otology for past 25 years and has the experience of performing around 12,000 Otological and Neuro - otological surgical procedures. In this book, she not only highlights the usual ossicular techniques but also describes her innovation in dealing with individual situations.

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